MONTANA DEPARTMENT OF ENVIROMENTAL QUALITY
Permitting and Compliance Division
Water Protection Bureau
P.O. Box 200901
Helena, Montana 59620-0901

Statement of Basis
Montana Ground Water Pollution Control System (MGWPCS)

Permittee: RAE Subdivision County Water and Sewer District No. 313

Permit No.: MTX000117

Receiving Water: Class I Ground Water

Facility Information:
Name: RAE Water and Sewer District

Location: NW ¼ of Section 16, Township 2 South, Range 5 East, Gallatin County

Contact: David King, Manager
129 Percival Path
Bozeman, Montana 59718
Phone (406)586-3930

Fee Information:
Number of Outfalls: One (1) For the purpose of fee determination.
Outfall(s)/Type: 001 - Subsurface Drainfield

I. PERMIT STATUS

This statement of basis is for a permit renewal for RAE Water and Sewer District (RWSD) pursuant to the Montana Ground Water Pollution Control System (MGWPCS). The previous permit was issued on May 22, 2001 (effective date was July 1, 2001) and expired on June 30, 2006. The permittee, RAE Subdivision County Water and Sewer District No. 313, submitted a MGWPCS GW-1 and Form 1 application for permit renewal that was received by the Department on June 19, 2007, in accordance with ARM 17.30.1023(4). A written request for supplemental information [ARM 17.30.1023(5)] was made by the Department on July 19, 2007. The application was determined to be complete [ARM 17.30.1024(1)] on August 26, 2008.

This facility is subject to the Montana Nondegradation Policy according to 75-5-303, MCA and in the Administrative Rules of Montana (ARM 17.30.701, et seq.). Based on the information provided in the permit renewal application (GW-1), no new or increased source of pollutants is proposed [ARM 17.30.702(18)]. The nondegradation review will be revised to address total nitrogen (TN) effluent limits instead of the total inorganic nitrogen (TIN) effluent limit used in the original permit.

This facility is subject to review and approval under the Public Water Supply Act (75-6-101, MCA et seq.). The applicant submitted plans and specifications for review. This information was reviewed by the State Revolving Fund (SRF) for the Department's Public Water Supply (PWS) Section and received final approval through PWS for the wastewater treatment system on November 6, 2002 (EQ#03-1370).

II. FACILITY INFORMATION

A. General Description

The RWSD wastewater treatment facility is located approximately two miles southwest of Bozeman. According to the original statement of basis (March, 2001), this wastewater treatment system is a publicly-owned treatment works (POTW) that treats domestic wastewater from 330 single-family residences and serves 830 people. The development is designed for a total of 1,000 single-residential lots at full build-out. There is one commercial business lot ("Signs and Designs", SIC 2759) that discharges residential-strength wastewater to the system.

B. Wastewater Collection, Treatment, and Disposal

Raw sewage and wastes are collected via a gravity sewer collection system that flows to a lift station. From the lift station, a six-inch diameter pipe sends the wastewater flow to a 30-inch wide, 2-foot high, 15-foot long channel with a flume. Where the channel narrows, influent flow is measured using an ultra sonic flow meter. At the headworks of the mechanical plant, a bar screen separates the solid waste material out of the waste stream prior to entering the sequencing batch reactor (SBR) for treatment. Grit and screenings are hauled to a licensed solid waste landfill.

The SBR is an advanced biological nutrient-removal, activated sludge wastewater treatment technology from Aqua-Aerobic Systems, Inc. This SBR system consists of two independent basins that allow one basin to be in the fill phase while the other is in the treatment phase. Treatment in each basin begins with a non-mixing/anoxic phase. As the influent continues to enter the first basin (reactor-phase), mixing with aeration begins. Once the influent flow is terminated, mixing and aeration continue on an intermittent basis to promote nitrification/de-nitrification. After mixing and aeration, settling occurs to allow the solids and liquids to separate. The liquid is decanted off and goes to the post equalization basin. From the post equalization basin, the effluent (liquids) receives ultraviolet (UV) disinfection prior to discharging to the subsurface via one of three infiltration galleries.

The infiltration galleries receive the liquid portion of the effluent and are aligned lengthwise for a total of 770 feet. Each gallery consists of two 250-foot (2.5-inch diameter PVC) laterals spaced approximately 15-foot on center with 3-foot wide infiltrator trenches. The infiltrator assemblies (12-inch high), which are described as "high capacity" are placed over 6 inches of washed rock and extend into the underlying clean gravel layer. The increased head allows faster infiltration. The galleries are slightly mounded to provide adequate separation between the bottom of the infiltrators and ground water. Infiltrators are covered with 6 inches of washed rock and geotextile fabric.

Sludge (1,900 gallons per day) is routed to the aerobic digesters and remains there for 20 to 30 days. Six-hundred gallons per day (gpd) of sludge are discharged to lined reed beds (see Attachment 1) where it is treated and stored. The reed beds are lined and have an under-drain where liquids collect (1,300 gpd) and are re-routed through the treatment system. Final disposition of the sludge is onsite compost.

Table 1: RAE Subdivision County Water and Sewer District - Design Information	
Construction Date: Existing	Modification Date: Not Applicable
Design Population: 1,000 single family residences	Estimated Population: currently 830 people
Design Flow, Average (gpd): 200,000	Design Flow, Peak (gpd): 250,000
Disinfection (Y/N): Y	Type: ultraviolet (UV)
Disposal Method: Subsurface Drainfield	
Effluent Flow Meter(s): influent channel flume with ultra-sonic measurement and McCrowmeter effluent flow meter	
Sludge Pumping and Hauling: onsite to reed beds with final disposition as onsite compost	
Disposal: grit and screenings go to a licensed solid waste landfill	

Advanced phosphorous removal is also achieved during the SBR treatment process. Phosphorous removal occurs in the mixed fill (anoxic) phase when phosphorous is released from the cell mass in the reactor and goes into solution. As the react (aerobic) phase proceeds, phosphorous is ingested by the (sludge) cell mass where it will remain throughout the rest of the batch process. The ingested phosphorous is removed from the reactor basin(s) during sludge wasting and is discharged to the aerobic digesters.

At RWSD, the SBR treatment equipment is constructed partially below the ground surface and housed beneath a heated greenhouse-type building to prevent freezing in the winter months. There is a separate building for the blowers, which provide air for the aeration phases in the SBR treatment. There is also a building for the UV disinfection equipment, which operates year-around. A McCrowmeter (MW500, propeller-type) flow meter measures effluent flow prior to discharge to the infiltration galleries, which discharge to the shallow ground water.

The applicant has requested to discharge effluent at an average daily flow rate of 200,000 gallon per day (gpd), which is consistent with the original permit.

III. DESCRIPTION OF THE DISCHARGE

A. Outfall location

The permit renewal authorizes the permittee to discharge residential strength wastewater from a SBR wastewater treatment system to three infiltration galleries (Outfall 001) located on the property.

- Outfall 001 is located northeast of the residential development area.

B. Past Monitoring Data/Effluent Characteristics

The permittee has provided the required self-monitoring data [i.e., discharge monitoring reports (DMRs)] for approximately 5 years (50 months). Analytical data has been reported from monthly effluent grab samples collected following the UV disinfection unit prior to discharging to the infiltration galleries, which discharge to the shallow ground water. In general, historical analytical effluent data collected at

RWSD over the course of the previous 5-year permit cycle have demonstrated compliance with the permit limits (see Table 2).

No mass balance calculations were provided for a water quality-based effluent limit for total inorganic nitrogen (TIN) in that SOB, since the permittee supplied the effluent limit of 5 mg/L. Therefore, the permit effluent limit was assigned based on the permittee's judgement and historical studies (Allied, 2000), as stated above.

The annual average permit load limit for total phosphorous (TP) was 1,060 lbs/yr (2.9 lbs/day). Monthly effluent grab samples for the analysis of TP have been collected from the discharge line following UV treatment, prior to final discharge to the infiltration galleries. The TP analytical data have been reported on a monthly frequency.

Table 2: Outfall 001 Effluent Characteristics [1] for the POR April 1, 2004 to May 31, 2008.

Parameter	Location	Units	Previous Permit Limit	Minimum Value	Maximum Value	Average Value	Number Of Samples
Flow, Daily Average	Domestic Supply	gpd	200,000	8,640	119,520	63,271	50
Biochemical Oxygen Demand (BOD_5)	Influent	mg/L	[3]	[2]	[2]	[2]	[2]
	Effluent	mg/L	30	<2	17	4.3	50
Total Suspended Solids (TSS)	Influent	mg/L	[3]	[2]	[2]	[2]	[2]
	Effluent	mg/L	30	1	57	9.1	50
Fecal Coliform Bacteria	Effluent	No./100ml	50	<1	170	8.2	50
pH	Effluent	s.u.	[3]	[2]	[2]	[2]	[2]
Specific Conductance	Influent	mg/L	[3]	[2]	[2]	[2]	[2]
	Effluent	µS/cm	[3]	[2]	[2]	[2]	[2]
Chloride	Effluent	mg/L	[3]	4.2	78	35.8	50
Ammonia, as N	Influent	mg/L	[3]	[2]	[2]	[2]	[2]
	Effluent	mg/L	[3]	<0.1	15.9	1.7	50
Kjeldahl Nitrogen, as N	Influent	mg/L	[3]	[2]	[2]	[2]	[2]
	Effluent	mg/L	[3]	[2]	[2]	[2]	[2]
Nitrate + Nitrite, as N	Influent	mg/L	[3]	[2]	[2]	[2]	[2]
	Effluent	mg/L	[3]	0.1	6.3	1.6	50
Total Inorganic Nitrogen (TIN)	Influent	mg/L	[3]	[2]	[2]	[2]	[2]
		lbs/day	[3]	[2]	[2]	[2]	[2]
	Effluent	mg/L	5.0	0.45	17.0	3.3	50
		lbs/day	[3]	[2]	[2]	[2]	[2]
Total Nitrogen (TN)	Effluent	mg/L	[3]	[2]	[2]	[2]	[2]
Total Phosphorus	Influent	mg/L	[3]	[2]	[2]	[2]	[2]
	Effluent	mg/L	[3]	<0.03	5.5	1.9	47
		lbs/day	2.9[4]	0.02	2.43	1.04	47
Oil and Grease	Influent	mg/L	[3]	[2]	[2]	[2]	[2]
Total Dissolved Solids (TDS)	Influent	mg/L	[3]	[2]	[2]	[2]	[2]

Footnotes:

(1) Conventional and nonconventional pollutants only, table does not include toxics.
(2) Data not available: no samples collected for this parameter.
(3) No limit in previous permit.
(4) Annual Average Load (lbs/day)

IV. SITE CHARACTERISTICS

A. Soil

Five test pits were excavated to a maximum total depth of nine feet below the ground surface (bgs) to describe the soils in the vicinity of the discharge. The locations of these pits were focused on the east side of the area, including the northern and southern extremes. One to two feet of silty topsoil was described at this site and thinning of this layer to the north was evident by comparing the test pit data. Beneath the veneer of topsoil is a silty, loam-layer with gravel and cobbles that ranges from 2 to 3.5 feet thick. Locally, this layer thickens northward. All five test pits were terminated in clean sandy gravel with silt and 8-inch diameter cobbles. Shallow ground water was encountered in the gravel. The static water level ranged from 3.72 to 6.33 feet below ground surface (bgs) in the gravels.

B. Geology

Sediments in this area consist of alluvial fan deposits approximately 200 feet thick that are composed of silt, sand, and gravel from the Gallatin Range to the south. Northward the alluvial fan deposits meet with the alluvium from the Gallatin and East Gallatin Rivers, which is approximately 100 feet thick.

Less permeable, Tertiary-age deposits underlie the fan and alluvial deposits. These deposits consist of semi-consolidated clay, silt, sand and gravel (application information, 2007).

C. Hydrogeology

The shallow unconfined aquifer in this area is approximately 150 feet thick (Slagle, 1995).

D. Hydrology

The depth to ground water fluctuates at least 4 feet seasonally. Average static water levels (SWLs) from the four ground water monitoring wells in the vicinity of the discharge (i.e., hydraulically downgradient boundary of the source specific mixing zone) range from 6.84 to 10.48 feet below the top of the casing (TOC)

The hydraulic conductivity (K) is 43 ft/day (Hackett, 1960 and Slagle, 1995). The hydraulic gradient is 0.012 ft/ft to the N20°W (Slagle, 1995). The nearest hydraulically downgradient receiving surface water is an unnamed gravel pit, which is 2,620 feet from the outfall.

V. RECEIVING WATER

A. Water-Use Classification and Applicable Water Quality Standards

Effluent is discharged from the wastewater treatment facility to the shallow ground water. Applicable water quality standards for individual parameters of concern are established according to the receiving ground water classification based on specific conductivity in umhos/cm or microSiemens/cm. Specific conductivity values from ground water samples collected and analyzed from the four shallow ground water monitoring wells over the first permit cycle ranged from 311 umhos/cm (MW1A) to 917 umhos/cm

(MW2). Based on the average specific conductivity from the four shallow wells, which is 499 umhos/cm, the receiving water for Outfall 001 is Class I ground water.

According to ARM 17.30.1006 (Classifications, Beneficial Uses and Specific Standards for Ground Waters), the receiving water for Outfall 001 is Class I ground water. Class I ground water has a specific conductivity of less than or equal to 1,000 μmhos/cm at 25 degrees Centigrade, as defined by ARM 17.30.1006(1). According to ARM 17.30.1006(1)(a), the quality of Class I ground water must be maintained so that these waters are suitable for public and private water supplies, culinary and food processing, irrigation, commercial and industrial purposes, drinking water for livestock and wildlife, with little or no treatment. Human health standards listed in DEQ Circular 7 (February 2006) apply to concentrations of dissolved substances in Class I ground water.

Average ambient nitrate + nitrite (as N) in the shallow ground water is 0.72 mg/L based on analytical data from four (2 pair) shallow hydraulically downgradient ground water monitoring wells located at the hydraulically downgradient boundary of the 365-foot source specific ground water mixing zone. MW1 and MW2 are screened from 3 to 20 feet bgs in gravels (total depth is 20 feet). The deeper wells (MW1A and MW2A are screened from 35 to 50 feet bgs in gravel, and clay and gravel (total depth is 50 feet) (see Part X.C. of this statement of basis for more detailed well location and completion information).

The average depth to ground water in the four shallow monitoring wells ranged from 6.84 to10.48 feet (difference of 3.64 feet), demonstrating that all of these wells are completed in the same unconfined shallow aquifer but in slightly different lithologic zones (the lower zone having clay lenses). Ground water level data collected over the first permit cycle indicate fluctuations in SWLs were the largest in MW1 (4.21 feet) and MW1A (3.15 feet), which are located along the northwest boundary of the 365-foot source specific ground water mixing zone. These more extreme SWL fluctuations may suggest communication with a recharge area. SWL fluctuations in MW2 and MW2A were 1.65 feet and 1.8 feet, respectively.

The wells screened in the lower portion of the aquifer (MW1A and MW2A) have slightly higher average nitrate + nitrite (as N) concentrations (0.94 and 0.86 mg/L, respectively), than the shallower wells (0.48 mg/L at MW1, and 0.58 mg/L at MW2). Upgradient ground water samples used for previous permit application data needs were collected from three existing wells. The average background nitrate (as N) concentration is 0.89 mg/L.

The applicable ground water quality standards and nondegradation significance criteria are included in Table 3.

Table 3. Applicable Water Quality Standards and Nondegradation Nonsignificance Criteria

Parameter	DEQ Circular 7 Human Health Ground Water Standards	Nondegradation Significance Criteria in Ground Water for Conventional Treatment
Nitrate (as N)	10 mg/L	5.0 mg/L
Total Phosphorus	no standard	50 year breakthrough [(1)], mg/L
E-Coli Bacteria	<1 organism per 100 ml	<1 organism per 100 ml

[1] The phosphorus significance criteria is listed in ARM 17.30.715(1)(e): "changes in concentration of total inorganic phosphorus in ground water if water quality protection practices approved by the department have been fully implemented and if an evaluation of the phosphorus adsorptive capacity of the soils in the area of the activity indicates that phosphorus will be removed for a period of 50 years prior to a discharge to any surface waters."

VI. MIXING ZONE

A mixing zone, as defined in 75-5-103(18), "means an area established in a permit or final decision on nondegradation issued by the Department where water quality standards may be exceeded, subject to conditions that are imposed by the Department and that are consistent with the rules adopted by the Board." Requirements for granting a mixing zone are based on 75-5-301(4), MCA, which states that mixing zones must: (a) be the smallest practicable size, (b) have a minimum practicable effect on water uses, and (c) have definable boundaries. The Department has adopted rules implementing the nondegradation policy established in 75-5-303, MCA to provide that changes in nitrate (as N) in the ground water are nonsignificant if the discharge will not cause degradation of surface water and the predicted concentration of nitrate (as N) at the boundary of the ground water mixing zone does not exceed limits as specified in 75-5-301(5)(d), MCA.

The permittee must comply with the ground water mixing zone rules pursuant to ARM Title 17, Chapter 30, Subchapter 5. The Department shall assess the information received from the applicant concerning the biological, chemical, and physical characteristics of the receiving water as specified in ARM 17.30.506 or as requested by the Department. The Department will determine the applicability of a mixing zone, as well as the size, configuration, and location [see ARM 17.30.505(1)].

To qualify for a source specific ground water mixing zone (ARM 17.30.518), the concentration(s) of the pollutants at the hydraulically downgradient boundary of the mixing zone discharge must meet the nonsignificance criteria, as specified in ARM 17.30.715.

The permittee discharges all wastewater from Outfall 001. The permittee has requested a permit renewal for the originally permitted source specific ground water mixing zone extending 365 feet [ARM 17.30.518(2)] hydraulically downgradient from the outfall/discharge in a N20°W direction (Slagle, 1995).

The length of this mixing zone preserves a 100-foot boundary from the nearest domestic supply well. No mixing zone would be granted if it would threaten or impair existing beneficial uses [ARM 17.30.506(1)]. DEQ Circular 7 (February, 2006) human health-based ground water standards must not be exceeded beyond the boundaries of a mixing zone [ARM 17.30.1005(2) and ARM 17.30.508(1)(a)]. In addition, the zone of influence of any drinking water well will not be allowed to intercept a ground water mixing zone [ARM 17.30.508(2)].

Also, the permittee must comply with the ground water mixing zone rules pursuant to ARM Title 17, Chapter 30, Subchapter 5. The shape of the mixing zone is determined by using the dimensions of the outfall (three infiltration galleries) and information on water table elevations and topography.

The width of the three infiltration galleries, perpendicular to the direction of ground water flow is 770 feet. A source specific ground water mixing zone will be granted for an individual parameter of nitrate (as N) [ARM 17.30.505(1)(a)]. The renewed permit will use 5.0 mg/L of TN as the ground water permit trigger value at the end of the 365-foot source specific ground water mixing zone based on a conventional wastewater treatment system [see 75-5-301(5)(d)(ii), MCA and ARM 17.30.715(1)(d)(ii)].

VII. PROPOSED DISCHARGE LIMITS AND CONDITIONS

The Montana Water Quality Act (Act) states that it is unlawful to discharge sewage, industrial waste or other wastes into any state water without a current permit from the Department (75-5-605(2), MCA). The Act also sets forth duties of the Department that shall include the following: issue, suspend, revoke, modify, or deny permits 401(1), MCA; examine information in order to issue a permit or issue a permit with conditions 401(2), MCA; and specify limitations in the permit 401(3), MCA. The Act also establishes that rules shall be adopted governing the application, authorization and issuance of permits to discharge sewage, industrial wastes or other wastes to state waters, provided the limitation of said permits will not result in pollution of any state waters.

ARM 17.30.1031 states that all issued MGWPCS permits must contain conditions including, but not limited to, discharge limitations, which will assure compliance with the ground water standards given due consideration to the economics of waste treatment and prevention. ARM 17.30.1005(1) states, the standards in ARM 17.30.1006 establish the maximum allowable changes in ground water quality and are the basis for limiting discharges to ground water.

A. Nondegradation/Nonsignificance Based Effluent Limits (NBELs)

Montana's nondegradation policy (75-5-303, MCA) applies to any activity of man resulting in a new or increased source which may cause degradation [ARM 17.30.705(1)]. The applicant must demonstrate that existing uses of state waters and the level of water quality necessary to protect those uses will be maintained. Compliance for permitting purposes is accomplished through a significance determination by the Department. A determination of nonsignificant changes in water quality is based on the criteria set forth in ARM 17.30.715 regarding flow volume, carcinogenic parameters, toxic parameters, nitrate and phosphorous concentrations, harmful parameters, and parameters for which there are only narrative water quality standards.

The permittee has requested a permit renewal for the source specific 365-foot ground water mixing zone (see Part VI. of this statement of basis). Concentration-based limits for nitrate (as N) in the ground water at the boundary of any applicable mixing zone are established according to levels of wastewater treatment [75-5-301(5)(d), MCA and ARM 17.30.715(1)(d)]. Therefore, changes in nitrate (as N) in the ground water are considered to be nonsignificant when the predicted concentration of nitrate (as N) at the boundary of the ground water mixing zone does not exceed 5.0 mg/L from effluent discharged from a conventional wastewater treatment system [75-5-301(5)(d)(ii), MCA and ARM 17.30.715(1)(d)(ii)] .

1. Total Nitrogen (TN)

The applicant has described this wastewater treatment system as Level II [ARM 17.30.702(11)] treatment, but this particular SBR system (i.e., Aqua-Aerobic) has not been reviewed by the Department and has not received Department approval for Level II treatment capabilities (ARM 17.30.718).

The original permit effluent limit for total inorganic nitrogen (TIN) was based on the applicant's knowledge and historical studies of SBR's similar to the RWSD's system. According to the Allied Engineering Services, Inc. report (pg. 2, May, 2000) submitted as part of the original permit application information and re-submitted to the Department as information to be used with the application for the permit renewal, "SBR facilities located even in cold climates can achieve discharges with total nitrogen (TN) of less than 5.0 mg/L." In addition, "Based on the treatment capability of the SBR's, we conservatively assumed an effluent nitrate concentration of 5 ppm." (pg.8, Allied, 2000).

Therefore, an effluent permit limit of 5.0 mg/L for TIN [nitrate + nitrite (as N) plus ammonia (as N)] was required in the original permit. In the permit renewal, the effluent limit will be 5.0 mg/L total nitrogen (TN), which consists of nitrate + nitrite (as N) plus total Kjeldahl nitrogen (TKN), as N. TN is in accordance with terms defined in ARM 17.30.702(9), (10), and (11), which are based on criteria set forth in ARM 17.30.718 for the Departmental evaluation of nutrient reduction from subsurface wastewater treatment systems.

These limits are applicable to each effluent sample collected at the last point of control following the UV treatment prior to discharge to the outfall (i.e., infiltration galleries), which discharge to shallow ground water.

2. Total Phosphorous (TP)

This SBR wastewater treatment system has been previously approved for a phosphorous reduction of 1.7 mg/L. An evaluation of the phosphorous adsorptive capacity of the soils in the area of the activity indicates that phosphorous will be removed for a period of 50 years prior to a discharge to any surface waters. This meets the 50-year breakthrough criteria required according to ARM 17.30.715(1)(e) [see Section VIII.B. of this statement of basis].

Based on the performance of the system, the NBEL for TN and the load-based limit for TN and TP are set forth in Table 4. These effluent limits are applicable to effluent samples collected at

Table 4. Nondegradation-Based Effluent Limits (NBELs) for Outfall 001.

Parameter	**Daily Maximum Concentration (1) mg/L**	**30-Day Average Load(1) (pounds per day)**
Total Nitrogen, as N (TN)(2)	5	8.3
Total Phosphorus, as P (TP)	NA	3.0

(1) See definitions in Part V of this permit.
(2) Total Nitrogen (TN) is the sum of nitrate + nitrite (as N) and total Kjeldahl nitrogen (as N).
NA Not Applicable

B. Water Quality-Based Effluent Limits (WQBELs)

The Montana Water Quality Act states, it is unlawful to discharge sewage, industrial wastes, or other wastes into any state waters (75-5-605(1)(c), MCA). The Act requires that a discharge to state waters shall not cause a violation of water quality standards (75-5-605(1)(a), MCA). Water quality limitations must be established in permits (75-5-605(1)(b), MCA) to control all pollutants or pollutant parameters that are or may be discharged at a level which will cause, have reasonable potential to cause or contribute to an excursion above any state water quality standard. The permittee must comply with Montana Numeric Water Quality Standards set forth in DEQ Circular 7 (February 2008) and the protection of beneficial uses (ARM 17.30.1006).

Montana water quality standards (ARM 17.30.10 et seq.) define both ground water use classifications for all state waters and numeric and narrative standards that protect those designated uses. Permits are required to include water-quality based effluent limits (WQBEL) when nondegradation-based effluent limits are not adequate to protect state water quality standards.

With regard to the original statement of basis (SOB, pp.5 & 6, March 2001), a nitrate sensitivity analysis (identified as the Bauman and Schafer equation, 1984) was used to demonstrate that effluent discharged from the outfall to the shallow ground water would not exceed the nitrate limit of 5.0 mg/L at the end of the mixing zone. Based on the analysis, the calculations show the "concentration of nitrate plus nitrite as nitrogen (NO_3 + NO_2–N) in receiving ground water at the end of the mixing zone" is 4.12 mg/L. There was no mass balance calculation done basis to determine WQBELs in the original statement.

The mass balance calculation for the WQBEL for TN is provided below.

1. Total Nitrogen

The total nitrogen (TN) concentration is the sum of nitrate plus nitrite, as nitrogen (N) plus total Kjeldahl nitrogen (as N) [TKN]. TKN is the sum of ammonia and organic nitrogen components. Raw wastewater consists primarily of ammonia. Treatment in septic tanks and drainfields convert the ammonia to nitrate and nitrite, as N. Recirculating sand filters, trickling filters, and aerobic/anerobic treatment units, as well as unsaturated zone material beneath the drainfields also convert the organic N (TKN) to nitrate, as N. The Department assumes all of the nitrogen discharged to the drainfield in the effluent has been converted to nitrate, as (N) [DEQ, 2005].

The allowable discharge concentration is derived from the mass balance water quality equation [ARM 17.30.517(1)(d)], which considers dilution and the background concentration of the receiving water (EPA, 2000), pursuant to a source specific 365-foot ground water mixing zone [ARM 17.30.518(5)].

The allowable discharge concentration beneath the infiltration galleries (Outfall 001) is:

$$C_2 = \frac{C_3 (Q_1 + Q_2) - C_1 Q_1}{Q_2}$$

C_2 = 6 mg/L

C_1 = average ambient ground water (background) concentration, is 0.89 mg/L
C_2 = allowable discharge concentration (TN) beneath the infiltration galleries in mg/L
C_3 = ground water concentration limit for pollutant (from DEQ Circular 7 or other appropriate water quality standard) at the end of the mixing zone is 5.0 mg/L, instantaneous (no single sample shall exceed)
Q_1 = ground water volume is 6,454.19 ft^3 / day
Q_2 = maximum flow of discharge (average daily design flow of system is 26,738 ft^3 /day)

The volume of ground water that will mix with the discharge (Q_1) is estimated using Darcy's equation: Q_1 = K I A. The calculated value of Q_1 is 6,454.19 ft^3/day for the mixing zone; assuming an aquifer K value of 43 ft/day and a hydraulic gradient of 0.012 ft/ft (Slagle, 1995), and a cross sectional area of flow (using a depth to the limiting layer of 15 feet and a cross sectional area with tangent angles of 833.88 feet) at the downgradient boundary of the source specific 365-foot mixing zone of 12,508.13 ft^2.

The average daily design flow of the wastewater disposal system is 200,000 gpd, or 26,738 ft^3/day. The nitrate (as N) concentration must not exceed 5.0 mg/L at the end of the ground water mixing zone. The average ambient concentration of nitrate-nitrogen in the alluvial ground water is 0.89 mg/l (C_1). It is assumed that the entire TN load in the effluent converts to nitrate (as N) and enters the ground water.

As discussed in Part VII, nitrate reduction of approximately 7 percent is assumed to occur beneath the drainfield. Therefore, to discharge a TN concentration of 6 mg/L below the infiltration galleries, the effluent limit from the RSF system at the dose tank prior to discharge to the subsurface drainfields is calculated at 6.42 mg/L of TN.

6 mg/L (.07) = 0.42 mg/L	Assumed nitrate reduction beneath the drainfield.
6 mg/L + 0.42 mg/L = 6.42 mg/L	Maximum concentration of TN at the dose tank, prior to discharge to the infiltration galleries (Outfall 001).

The calculated effluent concentration of TN must not exceed 6.42 mg/L at the average daily design flow in order to maintain a concentration that is less than the state water quality standard of 5.0 mg/L for nitrate (as N) in the ground water at the mixing zone (Part VI) boundary. The WQBEL will be expressed as a load (lbs/day) based on the average daily design flow of the system (200,000 gpd) and the calculated maximum concentration as follows:

Load limit (lbs/day) per outfall = effluent flow rate (gpd) x daily maximum concentration (mg/L) **x** *(8.34 x 10^{-6})*
Load limit (lbs/day) per outfall= (200,000 gpd) **x** (6.42 mg/L) **x** (8.34 x 10^{-6})
Load limit (lbs/day) per outfall= 10.71 lbs/day

The WQBELs are summarized in Table 5.

2. Phosphorus

Total phosphorus of 10.6 mg/L is consistent with the concentration found in residential wastewater (EPA, 2002). However, this SBR treatment system has been previously approved for a phosphorous reduction of 1.7 mg/L. Therefore, the estimated load from this facility is approximately 0.003 pounds per day (lbs/day) per lot.

Phosphorus is removed mainly through soil sorption processes, which are slow and vary based on soil composition. The total phosphorus (TP) limitations are imposed to ensure that the quality of the effluent meets the nondegradation limit prior to discharge into any surface water [ARM 17.30.715(1)(e)]. The effluent limits do not include a concentration limit for phosphorus because the method used to determine compliance is the 50-year breakthrough analysis. The 50-year breakthrough nondegradation criterion is based on the amount of soil available to adsorb the phosphorus between the discharge point and the surface water using the average load of phosphorus from the wastewater source.

Based on the ground water flow direction of N20°W at this site, a phosphorous breakthrough analysis shows the breakthrough time to the nearest (2,620 feet) receiving surface water (unnamed gravel pit) is 50 years for the requested full build-out of 1,000 single-residence lots. Therefore, the discharge is considered nonsignificant degradation pursuant to the criteria of ARM 17.30.715(1)(e).

3. *Escherichia (E. coli)* Bacteria

The Department is not granting a mixing zone for *E. coli* bacteria because a properly sited and operated drainfield should remove most, if not all, of the pathogenic bacterial indicators within 2 to 3 feet of the drainfield's infiltrative surface (USEPA, 2002). The *E. coli* water quality standard is <1 colony forming unit (cfu) per 100 mL in the ground water (DEQ Circular 7, 2/2008). Based on the following site-specific criteria, ground water monitoring for *E. coli* bacteria will be required in the two existing shallow ground water monitoring wells (MW-1 and MW-2, each with a total well depth of 20 feet) at the hydraulically downgradient boundary of the 365-foot source specific mixing zone in the permit renewal.

- Monitor the efficiency of the UV disinfection in the shallow ground water.

- In the first permit cycle, fecal coliforms were measured in the effluent (generally below the original permit limit of 50 cfus) prior to discharge to the infiltration galleries, as well as in the shallow ground water at the end of the mixing zone.

The systematic usage of the three infiltration galleries will minimize saturated conditions and maximize the die-off rate in the natural sediments. The infiltration galleries discharge effluent approximately 3 to 5.6 feet bgs. This may provide adequate soil-subsoil materials where treatment may occur naturally in the unsaturated zone before discharging to the ground water.

In the event of an *E. coli* bacteria concentration detected above the water quality standard (less than 1 colony forming unit per 100 mL) in the ground water monitoring well at the end of the source specific mixing zone, the exceedance shall be verified by timely (72-hour) re-sampling. A validated *E. coli* exceedance confirming the presence of *E. coli* bacteria in the ground water will require additional disinfection to be added to the wastewater treatment system.

4. BOD_5 and TSS

Five-day biological oxygen demand (BOD_5) and TSS are monitored for wastewater treatment system efficiency to ensure the effective removal of biological material and that the proper aerobic biological processes are being maintained. There are no numeric ground water quality standards for BOD_5 and TSS, however according to ARM 17.30.1006(1)(b)(ii) the beneficial uses for a Class I ground water must be maintained. BOD and TSS are not subject to nondegradation unless they have a reasonable potential to

affect a beneficial use based on the significance criteria for BOD and TSS, which are narrative [ARM 17.30.715 (1)(g) and DEQ Circular 7].

Table 5. Water Quality-Based Effluent Limits for Outfall 001

Parameter	Daily Maximum[(1)] Concentration (mg/L)	30-Day Average Load[(1)] (pounds per day)
Total Nitrogen, as N [TN]	6.42	10.71[2)]
Total Phosphorus, as P [TP]	NA	3.0

(1) See definitions, Part V of the permit.

(2) When the WQBEL concentration is less than 26 mg/L TN, the WQBEL is used in the calculation of the load limit.

NA Not Applicable

VIII. PROPOSED FINAL EFFLUENT LIMITS

75-5-305(2), MCA states, that the Board shall establish minimum requirements for the control and disposal of sewage from private and public buildings**.** The proposed effluent limitations for Outfall 001 are summarized in Table 6 and are based on the more restrictive of the nondegradation and water quality-based criteria discussed in previous sections. The final proposed effluent concentration limit for TN is water quality-based, which encompasses the mass balance water quality equation [ARM 17.30.517(1)(d)] that accounts for dilution and the background concentration of the receiving water (EPA, 2000), pursuant to a source specific 380-foot ground water mixing zone [ARM 17.30.518(5)]. This assumes the expected performance of the SBR system and the infiltration galleries with proper operation and maintenance. The concentration limit is proposed to ensure the system operates within the nondegradation requirement of 7.5 mg/L nitrate (as N) at the mixing zone boundary [ARM 17.30.715(1)(d)(iii)], with an effluent concentration of TN at Outfall 001 not to exceed 9 mg/L beneath the infiltration galleries, as specified in ARM 17.30.517(1)(d)(iv).

The final proposed effluent load limit is proposed based on the design capacity and the WQBEL concentration [ARM 17.30.517(1)(d)(vi)]. The load limit for TN is based on complying with the nondegradation criteria of 7.5 mg/L for nitrate (as N) in ground water.

The effluent limit for TP is water quality-based as determined according to nondegradation significance criteria. The water quality-based effluent load limit considers the assimilative capacity of the soil system to estimate the maximum load of phosphorus discharged to the ground water without exceeding the 50-year breakthrough. The 90-day average load limit will provide protection for the surface and the ground water.

The effluent limits (see Table 6) apply to the treated effluent following UV treatment prior to discharge to the infiltration galleries as shown in Attachment 1.

Table 6. Numeric Effluent Limits for Outfall 001

Parameter	Daily Maximum Concentration (1) (mg/L) per Outfall	30-Day Average Load(1) (pounds per day) per Outfall
Total Nitrogen, as N (TN)(2)	5.0	8.3
Total Phosphorus, as P (TP)	NA	3.0

(1) See definitions, Part V of the permit.
(2) Total Nitrogen (TN) is the sum of nitrate, nitrite and total Kjeldahl nitrogen (as N).
NA Not Applicable

Other Discharge Limitations:

The average daily effluent design capacity discharged to Outfall 001 shall not exceed 200,000 gpd.

IX. MONITORING REQUIREMENTS

A. Influent Monitoring

The permittee will be required to monitor the influent for the constituents in Table 7, at the frequency and with the type of measurement indicated. Samples or measurements shall be representative of the volume and nature of the monitored raw waste stream. Influent sampling/monitoring shall be conducted on the raw sewage influent collected from the first point of control, which is where the flume comes into the plant prior to receiving treatment.

Table 7. Parameters to be Monitored in the Influent (at the first point of control)

Parameter, units	Frequency	Sample Type(1)
Influent Flow Rate, gpd(2)	Monthly	Continuous
Total Kjeldahl Nitrogen, as N (TKN), mg/L	Monthly	Composite
Nitrate + Nitrite (as N), mg/L	Monthly	Composite
Total Phosphorous (TP), mg/L	Monthly	Composite
Total Nitrogen (TN), mg/L	Monthly	Calculated(3)

(1) See definitions, Part V of the permit.
(2) To be measured with the existing ultra sonic flow meter located in the channel flume.
(3) Total Nitrogen (TN) is the sum of nitrate, nitrite and total Kjeldahl nitrogen (as N).

Other Influent Requirements:

The permittee shall monitor and report influent flow in the channel flume using the existing ultra-sonic flow meter located prior to entering the headworks of the treatment plant (see Part II.B. of this statement of basis).

Based on the influent and the effluent analytical data, a monthly percent removal shall be calculated for the parameters in Table 7 and Table 8. There must be at least a 60% removal of TN from the raw influent to Outfall 001. The percent removal shall be calculated using the following equation,

$$\frac{\text{Influent Concentration} - \text{Effluent Concentration}}{\text{Influent Concentration}} \times 100 = \%\ \text{removal}$$

B. Effluent Monitoring

Effluent monitoring is essential to ensure the effective treatment and consistency of the wastewater discharged from the facility. The effluent limits are established to protect the ground water from a change in water quality that would cause degradation [ARM 17.30.715] or cause a change in beneficial use [ARM 17.30.1005(1)]. Samples or measurements shall be representative of the volume and nature of the monitored discharge at the outfall.

The Department shall require effluent sampling using specified monitoring methods at designated locations and intervals (75-5-602(4), MCA). Effluent monitoring/sampling shall be conducted by collecting composite samples from the last point of control following the UV treatment system, prior to discharging to the infiltration galleries that is representative of the discharge (Outfall 001). A composite sample collected from at the last point of control shall be submitted to the laboratory for analyses of all of the parameters in Table 8.

These samples shall be collected at the frequency and with the type of measurement and sampling as indicated in Table 8 [ARM 17.30.1031(5)]. It is the responsibility of the permittee to establish and maintain records of all monitoring (75-5-602(1), MCA), and make reports of the required data to the Department (75-5-602(2), MCA). If no discharge occurs during the entire monitoring period, it shall be stated in a Discharge Monitoring Report (DMR) that "no discharge" occurred. The DMR shall be signed and submitted to the Department with the reporting period.

TABLE 8. Parameters To Be Monitored in the Effluent at Outfall 001

Parameter, units	Frequency	Sample Type[1]
Effluent Flow Rate, gpd[2]	Continuous	Continuous
Total Suspended Solids,(TSS), mg/L	Monthly	Composite
Biological Oxygen Demand (BOD_5), mg/L	Monthly	Composite
Total Kjeldahl Nitrogen, as N (TKN), mg/L	Monthly	Composite
NO_3+NO_2 (as N), mg/L	Monthly	Composite
Total Phosphorus, as P(TP), mg/L	Monthly	Composite
E. coli Bacteria, colony forming units/100 mL	Monthly	Grab
Total Nitrogen, as N (TN), mg/L	Monthly	Calculated[3]
Total Nitrogen, as N (TN), lb/d	Monthly	Calculated[4]
Total Phosphorus, as P (TP), lb/d	Monthly	Calculated[4]

(1) See definitions, Part V of the permit
(2) To be measured by a totalizing flow meter following UV treatment prior to discharge to the infiltration galleries.
(3) Total Nitrogen, as N = nitrate + nitrite, (as N) + total Kjeldahl nitrogen, (as N)
(4) See definition of "30-day (and monthly) average" in Part V of the permit.

The 30-day average load for TN and TP are the sum of the calculated loads for each TN and TP sample collected within the 30-day period, divided by the number of samples collected and analyzed for TN and TP.

The permittee shall install, use, and maintain monitoring equipment or methods (75-5-602(3), MCA). The effluent measurement method shall be either by recorder or totalizing flow meter; dose counts or pump run-times will not be accepted for wastewater systems undergoing permit renewal. The permittee has stated in the permit application that the method of effluent flow monitoring is the existing

McCrowmeter (MW500, propeller-type) totalizing flow meter. The permittee shall monitor the flow of the effluent for Outfall 001 at the meter, which is located following UV treatment prior to discharge to the infiltration galleries (see Attachment 1). The permittee shall report the flows for Outfall 001 based on the average (gpd) for each month.

C. Ground Water Monitoring

Ground water monitoring will be required in this permit due to the following site-specific criteria:

- Proximity of the shallow ground water to the surface. The average depth to shallow ground water at this site ranges from 6.84 to 10.48 feet bgs based on data from four shallow ground water monitoring wells at the end of the 365-foot source specific ground water mixing zone. In addition, SWL measurements have been as high as 5.6 feet below the top of the well casing (TOC) in MW1 (third quarter 2005), as reflected in the phosphorous breakthrough calculations.
- The unsaturated zone and the top of the shallow aquifer consist mostly of gravels, which offer limited natural treatment in the unsaturated zone and generally provide high transmissivities and hydraulic conductivities in the aquifer.
- Drinking water wells approximately 100 feet from the hydraulically downgradient 365-foot source specific mixing zone boundary.
- To ensure existing and future beneficial uses are protected in an area continuing to experience rapid growth and development.

The permittee is required to monitor the ground water quality at the hydraulically downgradient boundary of the source specific 365-foot ground water mixing zone. There are a total of four (two pairs) shallow ground water monitoring wells located approximately 365 feet from the hydraulically downgradient boundary of the 365-foot source specific ground water mixing zone boundary.

The four monitoring wells make up two pairs of 4-inch diameter PVC wells. The northwesterly monitoring wells are identified as the MW1 pair. MW1 is screened from 3 to 20 feet bgs in gravels (total depth is 20 feet) and MW1A is screened from 35 to 50 feet bgs in gravel, and clay and gravel (total depth is 50 feet). The northeasterly monitoring wells are identified as the MW2 pair. MW2 is screened from 3 to 20 feet bgs in gravel (total depth is 20 feet) and MW2A is screened from 35 to 50 feet in mostly gravel (total depth is 50 feet).

UV treatment has been operational throughout the original permit cycle and will be a requirement of the permit renewal. The parameters to be monitored and the sampling frequency for monitoring well MW1 and MW2 (shallow wells, total depth 20 feet) are given in Table 9.

Table 9. Ground Water Monitoring Parameters for Monitoring Wells MW1 and MW2 (Shallow wells, total depth of 20 feet)

Parameter, units	Frequency	Sample Type[1]
Static Water Level (SWL), feet below top of casing	Quarterly	Continuous
Nitrate (as N), mg/L	Quarterly	Grab
Total Kjeldahl Nitrogen (TKN), mg/L	Quarterly	Grab
Chloride, mg/L	Quarterly	Grab
E. coli Bacteria, cfu/100 mL	Quarterly	Grab
Specific Conductance, umhos/cm	Quarterly	Grab
Total Nitrogen, as N (TN) mg/L	Quarterly	Calculated

(1) See definitions, Part V. of the permit.

The parameters to be monitored and the sampling frequency for monitoring well MW1A and MW2A (deeper wells, total depth 50 feet) are given in Table 10.

Table 10. Ground Water Monitoring Parameters for Monitoring Wells MW1A and MW2A (Deeper wells, total depth of 50 feet)

Parameter, units	Frequency	Sample Type[1]
Static Water Level (SWL), feet below top of casing	Quarterly	Continuous
Nitrate (as N), mg/L	Quarterly	Grab
Total Kjeldahl Nitrogen (TKN), mg/L	Quarterly	Grab
Chloride, mg/L	Quarterly	Grab
Specific Conductance, umhos/cm	Quarterly	Grab
Total Nitrogen, as N (TN) mg/L	Quarterly	Calculated

(1) See definitions, Part V. of the permit.

The monitoring of chloride and specific conductance is used as indicators of potential impacts from the wastewater to the ground water.

Ground water sample collection, preservation and analysis shall be conducted according to ARM 17.30.1007 and "Non-Point Source Water Quality Standard Operating Procedures" (4/1/95) at http://deq.mt.gov/wqinfo/monitoring/SOP/pdf/10-0.pdf until the permit is issued. No later than 60 days from the date of permit issuance, the permittee shall develop and maintain onsite a site specific Standard Operating Procedure (SOP) manual and a Sampling and Analysis Plan (SAP) for monitoring and sampling the ground water monitoring well(s).

D. Corrective Action – Ground Water Trigger Values

The trigger values for ground monitoring wells MW1 and MW2 are listed in Table 11. An exceedance of a trigger value for either *E. coli* bacteria or nitrate (as N) will require a resample be collected from the monitoring well(s) within 72 hours of the laboratory notification of the analytical results from the scheduled sampling event. Corrective action will need to be implemented should the analytical results from the re-sample verify the exceedance(s).

Table 11. Ground Water Trigger Values for Monitoring Well MW1 and MW2

Parameter, units	Trigger Value
E. coli Bacteria, cfu/100 mL	Equal to or greater than 1
Nitrate (as N), mg/L	5.0

The trigger value for ground water monitoring wells MW1A and MW2A are listed in Table 12. An exceedance of the trigger value for nitrate (as N) will require a resample be collected from the monitoring well(s) within 72 hours of the laboratory notification of the analytical results from the scheduled sampling event. Corrective action will need to be implemented should the analytical result from the resample verify the exceedance.

Table 12. Ground Water Trigger Values for Monitoring Well MW1A and MW2A

Parameter, units	Trigger Value
Nitrate (as N), mg/L	5.0

Ground water corrective action could involve but not be limited to, one or more of the following measures based on the nature and extent of the potential impacts to the ground water quality.

- Identification of the probable cause and extent of the ground water quality changes.
- Installation of additional ground water monitoring wells, including an upgradient well.
- Increased sampling (frequency and/or constituents).
- Increase the efficiency of the wastewater treatment system.
- Reduce the amount of nutrients or other parameters discharged into the ground water.
- Additional disinfection to the effluent prior to discharge, if e-coli bacteria compliance limit was exceeded.
- Supply drinking water to hydraulically downgradient residences.

X. NONDEGRADATION NONSIGNIFICANCE DETERMINATION

The Department has determined the existing discharge is nonsignificant and there will be no degradation of state waters [Montana Nondegradation Policy [75-5-303, MCA; ARM 17.30.702(16)]. The applicable water quality standards for Class I ground water are summarized in Table 3. The effluent limits for TN and TP are based on compliance with water quality standards. The discharge will not exceed the water quality standard for nitrate (as N) of 5.0 mg/L at the hydraulically downgradient boundary of the source specific 365-foot ground water mixing zone.

XI. INFORMATION SOURCES

In the development of the effluent limitations, monitoring requirements and special conditions for the draft permit, the following information sources were used to establish the basis of the draft permit and are hereby referenced:

Allied Engineering Services, Inc., “RAE County Water and Sewer District No. 313 Wastewater Facility, Groundwater Discharge Permit Application”, with associated correspondence, May 4, 2000.

ARM Title 17, Chapter 30, Sub-chapter 5 - Mixing Zones in Surface and Ground Water, September 1999.

ARM Title 17, Chapter 30, Sub-chapter 7 - Nondegradation of Water Quality, March 2000.

ARM Title 17, Chapter 30, Sub-chapter 10 - Montana Ground Water Pollution Control System (MGWPCS), March 2002.

Bauman, B.J. and Schafer, "Estimating ground water quality impacts from onsite sewage treatment systems", Proceedings of the 4th National Symposium on Individual and Small Community Sewage Systems, New Orleans, ASAE, 1984.

Cherry, J.A. and Freeze, R. A., *Groundwater*, Prentice-Hall Inc., Englewood Cliffs, NJ., 1979. Chapter 2, pages 26-29.

DEQ Circular 4, 2004.

DEQ Circular 7 – Montana Numeric Water Quality Standards, February 2008.

DEQ, Memo-Regensberger, "Revised Modification of Phosphorous Concentration for Domestic Sewage in Nondegradation Reviews," October 29, 1998.

DEQ, "Nitrate Sensitivity Analysis Input Data", 1994.

DEQ, "Non-Point Source Water Quality Standard Operating Procedures" (4/1/95) at http://deq.mt.gov/wqinfo/monitoring/SOP/pdf/10-0.pdf

DEQ, "Statement of Basis for the Rae County Water and Sewer District No. 313", March 2001.

GWIC Database, http://mbmggwic.mtech.edu

Hackett, "Geology and Groundwater Resources of the Gallatin Valley, Gallatin Valley Montana", USGS Water Supply Paper #1482m, 1960.

Montana SSURGO Soils, GWIC

Slagle, Steven E., "Geohydrologic Conditions and Land Use in the Gallatin valley Southwestern Montana", 1992-1993, USGS Water Resources Investigation Report 95-4034, 1995.

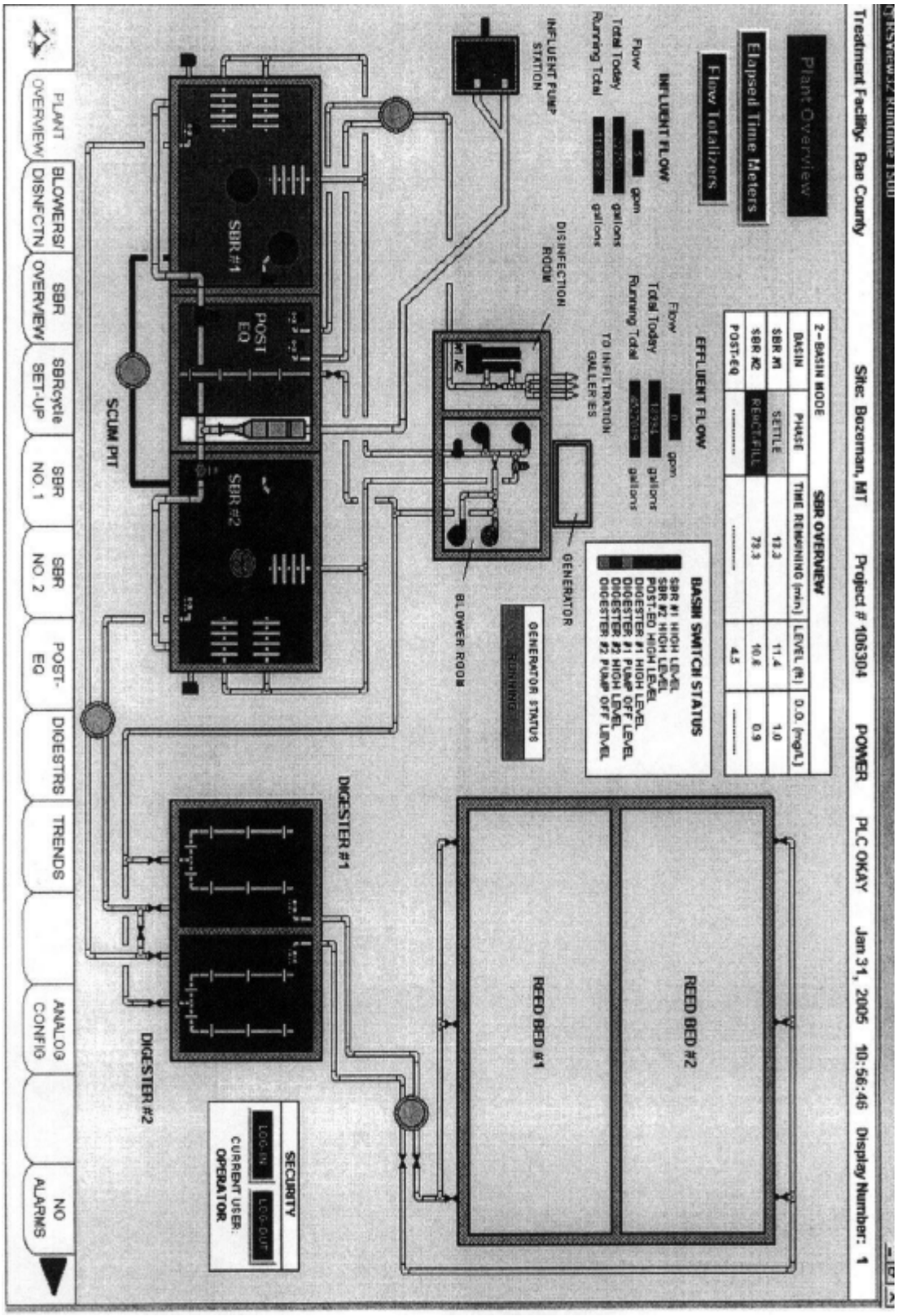
U.S. Environmental Protection Agency, Rev September 2000. U.S. EPA NPDES Permit Writers' Course, Helena, Montana, September, 2000, Workbook EPA 833-B-97-001.

U.S. Environmental Protection Agency, February 2002. *Design Manual: Onsite Wastewater Treatment and Disposal System*. EPA 625/R-00/008, p. 3-29 (Table 3-19) and Fact Sheet TFS-9 "Fixed Film Processes", and Table 1, TFS-51.

XII. ATTACHMENTS

Attachment 1 - Wastewater Flow Line-Diagram

Prepared by: Pat Potts **Date:** October 21, 2008



ATTACHMENT 1